BAP -03

Effect of Cottonseed Meal Supplemented with Phytase and Vitamin D_3 on Ileal Phosphorus Digestibility in Broiler Chickens Fed Diets Low in Calcium and Phosphorus

I.I. Ilaboya and E.A. Iyayi
Department of Animal Science, University of Ibadan, Ibadan
Corresponding author: I.I. Ilaboya; E-mail: bina.ilaboya@gmail.com: Tel: +2348058768730

Abstract
A total of 125 day-old Arbor Acre broiler chickens were fed broiler starter till day 20. On day 21, the chicks were weighed and allotted to 5 treatments with 5replicates of 5 birds each in a randomized complete block design. The treatments comprised a positive control (PC, T1) without cottonseed meal (CSM) and four CSM-based semi-purified diets, negative control (NC, T2), NC+vitamin D_3-10,000 IU/Kg (T3), NC+phytase (T4) and NC+phytase+vitamin D_3 (T5).Titanium dioxide(TiO_2) (5 g/Kg) was included as marker. On day 28, the birds were killed and digesta from the 2/3rd of the ileum collected. Digestible P was significantly ($p<0.05$) improved for birds on T5 when compared with the other four diets. Digestible P in T4 did not differ ($p>0.05$) from the birds on T1.Ileal digestible phosphorus (IPD) significantly ($p<0.05$) reduced with a corresponding increase in the percentage apparent phosphorus digestibility(APD) in T3, while T4 and T5 did not differ from T1 in the two parameters. It can be concluded that phytase and vitamin D_3 supplementation on cottonseed meal improved digestible P in broiler chickens.

Keywords: Cottonseed meal, phytase, vitamin D_3, ileal phosphorus, broilers

Introduction

Supplementation of non-ruminant diets (e.g pigs and broiler chickens) with microbial phytase and vitamin D_3 has been shown to improve calcium, copper, phosphorus and zinc utilization, and consequently reduce the excretion of these minerals in th efaeces (Adeola, 1995). The level of Ca in the diet may also affect the utilization of phytic acid-P through the formation of insoluble calcium phytate and/or reduction of phytase activity. Cholecalciferol (vitamin D_3) plays a role in Ca and P absorption, and therefore influences their utilization. Mohammed *et al.* (1991) reported that cholecalciferol supplementation of poultry diets increases phytic acid-P utilization. Cholecalciferol (D_3) is derived from 7-dehydrocholesterol in the skin of animals. Ultraviolet light transforms these compounds into 1, 25-dihydroxyl vitamin D_3, the vitamin D metabolite generally considered the most active. Metabolites of cholecalciferol may or may not improve phytic acid-P utilization in poultry or pig's diet.

Vitamin D_3 is best known for its role in Ca and P metabolism in skeletal development and maintenance, as well as egg shell strength. In addition, vitamin D_3 has been recognized for cell growth and differentiation (Brown *et al.,* 1999), as well as for its potential effects on the immune system (Reinhardt and Hustmyer, 1987), and reproduction (DeLuca, 1992). Calcium to phosphorus ratio and phosphorus content of diets also influence the inorganic P release from phytate by phytase (Poulsen *et al.,* 2010).

Animal feed contains high amount of calcium, calcium content in diet can have a large impact on phytate P utilization and phytase efficiency(Mohammed *et al.*, 1991).Increasing the Ca to total P ratio may have negative impact on phytase activity (Qian *et al.,* 1996). The authors reported that reducing dietary Ca:P ratio from 2:1 to 1.2:1 increased phytase efficiency by approximately 16% and improved performance and digestibility in weaning piglets. Similarly, Liu *et al.* (2013) concluded that lowering Ca:P ratio from 1.5:1 to 1:1 improved performance and P utilization in pigs fed low P corn soybean meal based diets supplemented with phyase. Inclusion of the appropriate amount of CSM will provide information on the amount of phosphorus digestible in broiler diets.

Hence the objective of this study is to determine the effect of supplementing low P diets containing CSM with vitD_3andphytase on ileal P digestibility in broiler chickens.

Materials and methods

One hundred and twenty five,1-day-old Arbor Acre broiler chickens was fed starter diet till day 20.A Positive control (PC) diet with required NPP (4.84 g/kg diet) and a Negative control (NC) diet in which the NPP is reduced by 65% (i.e. from 4.84 to 1.69 g/kg diet for CSM) was formulated. Three other diets each for CSM in which the NC diet is supplemented with either 1000 FTU phytase/kg diet, 10,000 IU. Vit D3/kg diet or both was formulated, making a total of 5 semi-purified diets.

Table 1: Gross composition of experimental diets (g/kg)

	PC	NC	NC+Vit D_3	NC+Phy	NC+Phy+Vit D_3
Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Cottonseed meal	0.00	315.00	315.00	315.00	315.00
Cassava Starch	608.00	469.00	468.75	459.00	458.75
Wheat gluten	250.00	100.00	100.00	100.00	100.00
Soya oil	10.00	2.00	2.00	2.00	2.00
Dextrose	90.00	90.00	90.00	90.00	90.00
Methionine	1.00	1.00	1.00	1.00	1.00
Lysine	1.00	1.00	1.00	1.00	1.00
Limestone	17.00	12.00	12.00	12.00	12.00
Vitamin-Premix	2.50	2.50	2.50	2.50	2.50
Salt	2.50	2.50	2.50	2.50	2.50
Phytase (FTU/kg)	0.00	0.00	0.00	10.00	10.00
Cholecalciferol (g/kg)	0.00	0.00	0.25	0.00	0.25
TiO_2 Premix	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate	13.00	0.00	0.00	0.00	0.00
Total	1000.00	1000.00	1000.00	1000.00	1000.00
Calculated Nutrients					
ME Kcal/Kg	3575.37	3158.31	3157.44	3575.37	3575.37
CP (g/kg)	218.00	217.61	217.61	217.61	217.61
Ca (g/kg)	10.85	5.64	5.64	5.64	5.64
Total P (g/Kg)	4.84	4.06	4.06	4.06	4.06
Non Phytate P (g/kg)	4.84	1.69	1.69	1.69	1.69
PhytateP (g/kg)	0.00	2.36	2.36	2.36	2.36
Ca : NPP ratio	2.24	3.33	3.33	3.33	3.33
Ca : P ratio	2.24	1.39	1.39	1.39	1.17

NC:Negative Control, PC:Positive Control, Phy:Phytase, Vit D_3:Vitamin D_3,NNP:Non phytate phosphorus

Results and Discussion

Table 2 shows that pre-caecal phosphorus in the diet supplemented with vitamin D_3significantly ($p<0.05$) reduced with a corresponding increase in the percentage apparent phosphorus digestibility (T3), while T4 and T5 did not differ from T1 in the two parameters. Digestible P was significantly improved for birds on T5 in comparison to the other four diets (T1, T2, T3 and T4). Digestible P in T4 did not differ ($p>0.05$) from the birds on the PC (T1) diet.

Table 2: Ileal, digested and apparent phosphorus digestibility of 28-day-old broilers fed cottonseed meal-based diets

	PC	NC	NC+Vit D_3	NC+Phy	NC+Phy+Vit D_3	SEM
Measurements	T1	T2	T3	T4	T5	
Ileal phosphorus (g/kg DMI)	0.20^{ab}	0.26^{a}	0.05^{c}	0.08^{bc}	0.11^{bc}	0.25
Digested phosphorus (g/kg DMI)	0.67^{c}	0.80^{bc}	0.83^{b}	0.79^{bc}	0.95^{a}	0.29
Apparent phosphorus Digestibility (%)	76.61^{b}	75.81^{b}	94.61^{a}	90.64^{ab}	90.11^{ab}	2.53

^{abc}Means in a row with different superscripts are significantly different from each other ($p<0.05$) PC= Positive control, NC: Negative control, Phy: Phytase, Vit D_3: Vitamin D_3

In this study, ileal P significantly reduced with the supplementation of vit D_3 and a corresponding increase in digestible P for birds fed a combination of vit D_3 and phytase (T5), percentage apparent P digestibility (APD) improved with the supplementation of vit D_3.These reports agrees with the work of Mohammed *et al.* (1991), these authors reported that cholecalciferol supplementation of poultry diets may improve phytic acid-P

utilization. Due to the reduced ileal P and increase in digestible and APD it can be concluded that phytic acid was effectively hydrolysed. Phytase supplementation has been reported to improve the amount of digestible P in plant feedstuffs and consequently reduce P loss from feed ingredient (Akinmusire and Adeola, 2009) as seen from the results of this study. There may also be an indirect effect of dietary Ca on P digestibility because vitamin D is activated at low Ca concentration, which may enhance both Ca and P absorption (Berner, 1997), and therefore increase P digestibility. Also when the dietary concentration of Ca is low, with the addition of phyase, P digestibility increases (Poulsen *et al.,* 2010). The positive effect of phytase on P digestibility is in agreement with results from experiments in which pigs were fed diets based primarily on canola meal (Akinmusire and Adeola, 2009) or barley and canola meal (Sauer *et al.,* 2003), and the increase in P digestibility is due to the release of P from phytate.

Conclusion and recommendation

Based on the results from this study, supplementation of cottonseed meal with Natuphos® phytase at 1000units/kg of diet and vitamin D_3 at 10000 UI/kg of diet reduced pre-caecal P and improved digested P and apparent P digestibility.

Farmers, researchers and Agricultural firms should be encouraged to supplement poultry diets with phytase and vitamin D_3as this will not only minimize eutrophication but decrease excessive dependence on inorganic phosphates in poultry.

References

Adeola, O. (1995). Digestive utilization of minerals by weanling pigs fed copper and phytase-supplemented diets. *Canadian Journal of Animal Science,*75: 603-610.

Akinmusire, A.S. and Adeola, O. (2009). True digestibility of Phosphorus in Canola and Soybean meal for growing pigs: Influence of microbial phytase. *Journal of Animal Science,*87: 977-983.

Berner, Y.N. (1997). Phosphorus - Handbook of nutritional essential mineral elements. B.L.O' Dell and R.A. Sunde, eds. Marcel Dekker, New York. Pp 63-93.

Brown, M.R, Mular, M., Miller, I., Farmer, C. and Trenerry, C. (1999).The vitamin content of microalgae used in aquaculture. *Journal of Applied Phycology,*11: 247-255.

DeLuca, H.F. (1992). Deficiency: New views on the function and health effects of vitamins. *Annals of the New York Academic of Sciences,*669: 59-68.

Liu, J.B., Chen, D.W. and Adeola, O. (2013). Phosphorus digestibility response of broiler chickens to dietary calcium to phosphorus ratios. *Poultry Science,* 92:1572-1578.

Mohammed, A., Gibney, M.J. and Taylor, T.G. (1991). The effects of dietary levels of inorganic phosphorus, calcium and cholecalciferol on the digestibility of phytate phosphorus by the chick.*British Journal of Nutrition,*66: 251-259.

Poulsen, H.D., Carlson, D., Organd, V.N. and Blaabjerg, K. (2010). Phosphorus digestibility is highly influenced by phytase but slightly by calcium in growing pigs. *Livestock Science,*134:100-102.

Qian, H., Kornegay, E.T. and Veit, H.P. 1996. Effect of supplemental phytase and phosphorus on histological mechanical and chemical traits of tibia and performance of turkeys fed soybean meal based semi-purified diets high in phytate phosphorus. *British Journal of Nutrition,*76:263-272.

Reinhardt, T.A. and Hustmyer, F.G. (1987).Role of vitamin D in the immune system. *Journal of Dairy Science,*70: 952-962.

Sauer, W.C., Cervantes, M., He, J.M. and Schulze, H. (2003). Effects of phytase supplementation to barley-canola meal and barley-soybean meal diets on phosphorus and calcium balance in growing pigs. *Interciencia,*28:476-481.